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Preliminary report; The geology of the Cranberry Island Formation and Deadman Point Formation, Cranberry Islands, the Swans Island Formation, Swans Island, and the Calderwood Formation, Vinalhaven Island, Maine

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Introduction

The volcanic rocks of the Cranberry Islands and Swans Island, and the Calderwood Formation of Vinalhaven Island were mapped for the following reasons: (1) to look for sources of the clasts in the Silurian conglomerates of the coastal volcanic belt (Gates 1989 in press); (2) to determine the stratigraphic relations of the rocks to the neighboring formations; and (3) to evaluate various proposals for their island to island correlation.

Preliminary compilation of the geologic maps and study of thinsections show that questions of field identification of lithologies and of structures remain and require field checking prior to submission of the final report.

Cranberry Islands

The volcanic rocks of the Cranberry Islands have customarily been divided into two members of the Cranberry Island Series (Dow 1965; Gilman and Chapman (1988). However, the two members differ markedly in lithology and structure; and the stratigraphic relation between them is uncertain. Hence I have divided the former Cranberry Island Series into two formations; the felsic Great Cranberry Island Formation exposed on Great Cranberry island and Little Cranberry Island and the Deadman Point Formation exposed on the southern one-third of Great Cranberry Island.

Great Cranberry Island Formation. Consistent dips, a few with facing direction indicators, to the south along the west shore of Great Cranberry Island indicate that the formation youngs to the south. Eight lithologic units, A through H, are sufficiently distinguishable to be mapped as members. The thicknesses given are based on exposures along the west shore of Great Cranberry Island as mapped and assume an average dip of 55 degrees to the south.

Member A. The exposed thickness is 125 m, the base unexposed beneath the sea. Member A consists primarily of a coarse polymict roundstone conglomerate and intermixed polymict breccia. The pebbles, cobbles. and a few boulders are unsorted except for a few poorly defined lenses of a different clast-size range from the surrounding conglomerate. The clast supported clasts include felsic volcanics (80%), mafic lava flows (15%), hypidiomorphic granular granodiorite and granophyre (2%), and unidentified (15%). No sedimentary or metamorphic clasts were found.

Member B. The conglomerate is overlain by a section, about 210 m thick, of coarse tuff-breccia, bedded lapilli tuffs, and thinly laminated argillites and siltstones, some with cross-bedding. Clasts are of broken feldspar crystals, and felsic devitrified volcanics. The matrix is siltstone partly replaced by fine-grained olive brown biotite. Near the top of Member B, the bedding becomes disrupted. Contact with member C is covered by a short gravel beach.

Member C. This member, about 140 m thick, consists of lenses and irregularly shaped blocks of tuff-breccia, felsic lapilli tuffs, tuffaceous sandstones, siltstones, and mudstones up to several meters in length in a matrix of mudstone and siltstone. Member C represents an original section of bedded volcanic rocks and fine-grained sediments that was disrupted by slumping or landsliding and emplaced as a debris flow.

Member D. This is a 85 m thick sequence of well-bedded volcanogenic sedimentary rocks exposed primarily on the point that makes the southern end of Perbble Cove. Lithologies include 1-3 m thick beds of coarse felsic tuff-breccia, thinner (20-50 cm thick) beds of pebble conglomerate of volcanic clasts, and thin (5-20 cm thick) beds of tuffaceous siltstone and mudstone. Beds are lenselike and discontinuous, some have soft-sediments deformation and disruption, and some have cross-bedding and cut-and-fill structures. Fluvial deposition is most likely. Member D is the same kind of bedded sequence that was disrupted to form Member C.

Member E. Member E can be traced to Long Point on the east shore of Great Cranberry Island and to the north shore of Little Cranberry Island. It thickens from about 25 m thick to about 420 m in the middle of Great Cranberry Island where it is made up largely of a massive thick tuff-breccia unit (E1). It is a complex of flowbanded locally sperulitic devitrified vitrophyre, auto-breccia of the same vitrophyre, coarse tuff-breccia largely of flowbanded fragments, and lenses of bedded volcanogenic rocks like those of Member D. Thinsections show that the some of the vitrophyre has a granular matrix of quartz and feldspar suggesting a dacite to rhyolite composition. Pending further study, it appears to be part of a multiple growth dome.

Member F. Member F has a consistent thickness of about 430 m. It is exposed along the west and east shores of Great Cranberry and Little Cranberry islands. Its apparent great thickness along the northeast shore of Little Cranberry Island is interpreted to be the result of folding. Where the contact with Member E is exposed at Bunker Head on Little Cranberry Island, the underlying bedded rocks of Member E form inclusions in Member F. On Marsh Head the upper contact consists of multiple tongues of Member E apparently intrusive into Member H. It thus may be a sill intruded along the contact between Members E and F.

In outcrop, Member F has white euhedral phenocrysts of feldspar and thin short light-colored seams oriented parallel to the base of Member F and thought to be collapsed pumice originally. In thinsection, the rock consists of very hydrothermally altered feldspar phenocrysts, now largely albite, calcite, and serecite in a matrix of fine-grained granular quartz, feldspar, and chlorite due to devitrification of an originally glassy rock. The thin seams were of quartz. No shards or pumice were identified.

The round area of Member F within Member D is interpreted to be a small plug that was the conduit for the former.

Member G. This member, about 156 m thick, is exposed along the west shore of G reat Cranberry Island but can not be traced further east. Its upper and lower contacts are not exposed. It consists of bedded tuffaceous siltstones and cross-bedded sandstones and conglomerates of mudstone chips in a feldspathic siltstone matrix. Some of the bedding is disrupted.

Member H. Member H is poorly exposed in the interiors of the Cranberry Islands, but outcrops along the shoreline and on the Baker Island Bar suggest a thickness of 1300 m. However, faulting and folding in the Bar Point area and to the south on Baker Island Bar may repeat much of the member. It is composed of lenses and blocks of a wide variety of tuffaceous sedimentary rocks and felsic and basaltic volcanics, representative of the general litholgies of the older members, in a matrix ranging from angular fragments of the same general lithologies to tuffaceous siltstone in which the lenses and block float. Within this section of disrupted rocks are sequences, up to 10 m thick, of well-bedded waterlaid tuffs, pebble conglomerates, and siltstones. The matrix contains replacement muscovite and brown biotite, and clots of granular quartz and epidote.

Along the west shore of Great Cranberry Island as the fault contact with the Deadman Point Formation is approached, cleavage becomes increasingly strong, wrapping around the blocks and lenses and locally forming boudons. Some of the blocks and lenses of siltstone and tuff have tight steeply plunging folds in which the limbs are sheared off against the cleaved matrix. This strong cleavage is also present on the Baker Island Bar. In thinsection the cleavage appears to be mylonitic.

Member H is a thick pile of debris flows separated by episodes of water-deposited sedimentation and shed off a terrane having volcanics and unconsolidated fine-grained sediments much like the underlying rocks. Members A and C also are debris flows. During deposition of much of the Great Cranberry Island Formation, there must have been steep slopes and unstable tectonic conditions.

The volcanic rocks of the Great Cranberry Island Formation have been hydrothermally altered to minerals of the greenschist facies, although original textures remain. Plagioclase feldspars are albitized and some are replaced by calcite, chlorite, and epidote. Once glassy rocks have been devitrified to a fine-grained mosaic of quartz, feldspar, and chlorite. As the contact with the Deadman Point Formation is approached actinolite needles replace chlorite and the amount of epidote increases. Fine-grained olive-brown biotite occurs in fractures and shears or generally replaces the fine-grained matrix of some volcanics and appears to be a younger metamorphic mineral than those of the hydrothermal alteration.

Deadman Point Formation. The Deadman Point Formation is named for exposures of sheared, folded, and metamorphosed siltstones on Deadman Point on Great Cranberry Island. However, in most of the formation the siltstones are interlayered with basalt flows and thin intrusions. The formation is much more deformed than all but the upper part of Member H of the Great Cranberry Island Formation and has been metamorphosed to the epidote-amphibolite grade, perhaps by the granite that intrudes it along the south shore. It is too intimate a mixture of basalt and bedded rocks to permit division into members, but exposures of mixed areas are schematically shown with S and L symbols for sediments and lavas.

The contact with the Great Cranberry Island Formation is beneath a gravel beach on the west shore of the island, but a small outcrop exposed at low tide of highly sheared rocks that in thinsection are mylonites suggest that the contact is a fault. This presumed fault contact is extended across The Heath (hence the name Heath Fault) as far as The Maypole on Little Cranberry Island because there the lithologic contrast between the two formations is present. However, the extension of the fault to pass north of Bar Point through two gravel beaches on each side of the point is conjecture as both sides of the presumed fault there are in Member H of the Great Cranberry Island Formation.

The best exposures of sedimentary rocks are south of Heath fault on the west shore and on Deadman Point. Near the fault, a south-dipping section consists of persistent beds that can be followed for many meters along the outcrop and range from a few centimeters to about 40 cm thick. The bedding is marked primarily by differences in color, white, epidote yellow, green, and lavender, and within beds these colors may give the rock a streaked or splotchy appearance. Thinsection study shows that the colors reflect various metamorphic minerals; granular quartz, grenular epidote, blue-green fibrous hornblende, and late biotite primarily responsible for the lavender color. Although the rock has been recrystallized, an original premetamorphic cataclastic foliation is suggested by augen and fluxion structures marked by differences in grain size and amounts of the metamorphic minerals which in themselves are not oriented. Minor minerals include sphene, apatite,and minute garnets. The metamorphic mineral assemblage indicates that the rocks were probably calcareous shales and siltstones that were cataclastically deformed and then thermally metamorphosed, perhaps by the nearby granite.

The exposures on Deadman Point have the same general metamorphic mineral assemblage with the possible addition of some fine-grained hedenbergite, toofinely granular to be clearly resolved by the microscope. Although the rocks on Deadman Point are folded and cleaved, penetrative cataclastic deformation is less than near the fault. Small-scale crossbedding and soft-sediment deformation have been preserved except where erased by the late biotite replacement.

The mafic lava flows were probably originally basaltic, but cataclastic penetrative deformation and thermal metamophism have left only suggestive remnants of original texture and mineralogy. The flows range in thickness from about 8m to 30m, have hornblende filled stretched or almost flattened vesicles, rubbly flow tops, and disrupted underlying sediments as if the lavas were extruded on soft silts and muds. A few basalts show tops that are a mixture of vesicular blocks and highly distorted sedimentary rocks as if the lavas were intruded into soft sediments. Most lava-sedimentary rock contacts are strongly sheared.

As seen in thinsection, original vesicles are flattened into streaks and augen of unoriented fibrous hornlende. Feldspar is preserved only in the "tails" of the augen. Most of the basalt(?) is a mat of fibrous hornblende, granular epidote, and late biotite that forms irregular patches or is concentrated in shear zones. Where very cataclasically deformed, the lavas consist of discontinuous streaks of white (in outcrop) fine-grained feldspar, largely anhedral albite, and flattened lenses of green hornblende, occasionally with a little fine-grained granular quartz. This green-white streaked rock in outcrop was nicknamed "zebra rock".

Structure

The Great Cranberry Island Formation as exposed along the west shore of the island is a homoclinal sequence dipping south. The folds delineated by Member F along the northwest shore of Little Cranberry Island were mapped on the basis of the very large increase of exposed rocks, changes in the attitude of the quartz seams, repetition of the flowbanded rocks of Member E, and two outcrops of Member H inland. A fold plunging to the the southwest occurs at the Maypole and an overturned fold is indicated by overturned beds at Bar Point.

The Great Cranberry Island Formation has a vertical or nearly so fracture cleavage locally and is strongly cataclastically foliated as the Heath Fault is approached.The rocks on Baker Island Bar also have a very string cleavage and some changes in dip of bedded rocks suggests folding.

The Heath Fault and the Dolly Hill Fault are the only tw faults mapped, although highly sheared zones in the Deadman Point Formation suggest that other faults may be present but can not be traced due to limited outcrop. The evidence for and the problems with the Heath Fault have already been described. The Dolly Hill fault is marked by a zone of highly sheared "zebra rock"; the cut-off of the southwest striking bedded rocks on Deadman Point, and the change to the west of the strike of the bedding, foliation, and folds south of the fault. Furthermore the section of interlayered sediments and lavas west of Bunker Head resemble the section of sediments and lavas south of the Heath Fault on the west shore of Great Cranberry Island.

North of the Dolly Hill Fault, the bbedded rocks on the Deadman Point, Crow Island, and Thrumcap strike northeast, have steep dips, a locally strong cataclastic cleavage essentially blastomylonitic, and two sets of folds both plunging steeply to the southwest, one set of open folds, the other of tight folds. Assymetry of the folds and offsets along the cleavage suggest left lateral simple shearing. There is also a faint cleavage that strikes west parallel to the blastomylonitic foliation in the rocks south of the Dolly Hill Fault.

South of the Dolly Hill fault the bedded rocks are interlayered with lava flows and probably sill-like intrusions. The strikes of the very strong blastomylonitic foliation and steeply west plunging folds are to the west or westsouthwest.

Outcrops in the interior of Great Cranberry Island and on the shores of The Pool are insufficient to delineate the overall stucture of the Deadman Point Formation. Dips to the south near the Heath Fault and the preponderance of facing directions to the northwest in the folded rocks of Deadman Point suggest that Deadman Point Formation is in a syncline, presumably plunging to the southwest in conformity with the minor folds. This presumed syncline is truncated and offset by the Dolly Hill fault on the south and the Heath Fault on the north.

Brookins and others (1973) reported an Early Devonian Rb/Sr age for felsic volcanic rocks of the Great Cranberry Island Formation. The granite along the south shore, undated but presumably Devonian, cuts the deformed and metamorphosed rocks . Hence both the deformation and thermal metamorphism is probably of Acadian age.

Uncertainties about the structural relationships between the Great Cranberry Island and Deadman Point Formations prevents determination of their stratigraphic relationship. Further field work hopefully will provide further information on the structural and hence stratigraphic relation between the two formations.

Intrusive rocks

Numerous diabase dikes with north, northeast, and northwest strikes intrude the Great Cranberry Island formation, some of which are offset by minor faults and hydrothermally altered. These are probably a late phase of the volcanism. However, a suite of northeast-striking diabase and diabase porphry dikes cut across the structures of both the Great Cranberry Island and Deadman Point formation. On Bar Point and Baker Island Bar these dikes parallel the foliation but are not themselves foliated. A few late unfoliated dikes in both formations are quartz porpyries. There are also a few fine-grained to aplitic granitic dikes. The granite along the south shore of Great Cranberry island has a sharp cross-cutting contact with the Deadman Point formation and has a fine-grained chill zone only a few inches thick in some dike-like offshoots. The temperature of the wall rocks must have been close to that of the magma during intrusion.

Age relations

Gilman and Chapman (1988) assigned a Siluro-Devonian age to the Cranberry Island Series (Great Cranberry Island and Deadman Point Formations of this report). Brookins and others (1973) gave a 387+-9 m.y. Rb/Sr age for the felsic rocks of the Cranberry Island Series. However, Lux (personal communication 1988) reported a 218-220 Ma age for the Cadillac granite on Mt. Desert Island which intrudes (with its surrounding breccia zone) the Southwest Harbor granite which in turn intrudes the Cranberry Island Series according to Gilman and Chapman (1988). Thus the later should be no older than Middle Silurian. This discrepancy in isotopic dates remains to be resolved.

Because of the presumed fault contact between the Great Cranberry Island and Deadman Point Formations, the stratigraphic position and hence age of the later is unknown.

Swans Island

The volcanic rocks of Swans Island crop out in the northeast part of the island. The remaining part is underlain by granite, presumably of Devonian age and not mapped.

Swans Island Formation. The bimodal suite of basalts and rhyolite on Swans Island is hereby named the Swans Island Formation. The outcrop pattern and a few bedding attitudes indicates that the formation dips to the northeast. The dips of bedded rocks range from 25 to 60 degrees, much steeper than the shallow dip suggested by the trace of the contacts between members across the topography. The formation may be folded into a broad open syncline plunging to the northeast. Three members have been mapped.

Member A. This lowermost member is almost continuously exposed along the shore of Mackerel Cove. It consists of penetratively sheared and thermally metamorphosed siltstones, thin basalt flows, and felsic tuffs and flowbanded rocks which have been folded.The thermal metamorphism as at the epidote-amphibolite grade. The deformation, folding, and metamorphism probably reflect a contact metamorphic zone associated with intrusion of the nearby granite. Along the east shore in the East Point-Otter Pond area, Member A consists of hornfelsed siltstones, bedded felsic lapilli tuffs overlain by the basalt of Member B,and a dike-like apparently intrusive zone of polymict breccia of felsic volcanic fragments perhaps related to intrusion of the granite that approximately parallels it.

Member B. This member is pile of basalt flows about 480 m thick with a few interbedded cross-bedded and graded-bedded siltstones. The contact with Member A along the east shore of Mackerel Cove requires further investigation as it is complicated by the deformation and metamorphism of Member A. The best exposures of basalt are on High Head and East Point. The flows have rubbly scoriaceous tops and vesicles are filled with chlorite, epidote, and calcite. Some flows are porphyritic. Original basaltic textures remain but original plagioclase and pyroxene have been metamorphosed to a greenschist assemblage of albitized plagioclase, chlorite. actinolite, and epidote. The basalts are fractured but lack cleavage.

Member C. The upper contact is not exposed. The thickness as measured on the map assuming a 45 degree dip of 460 m is thus a minimum. The contact with the underlying basalt was located within about 150 feet but never seen. Member C is a flowbanded rhyolite or dacite that has been devitrified to a fine-grained mat of quartz and feldspar with a little chlorite. The tightly folded banding together with some zones of autobreccia suggest a highly viscous flow or series of flows.

Member A resembles the Calderwood Formation on Vinalhaven Island in its penetrative shearing and epidote-amphibolite metamorphism. Member C resembles Member E of the Great Cranberry Island formation but is much thicker and more uniform. No volcanic rocks on the Cranberry Islands or on Vinalhaven match the thick basalts of Member B.

Vinalhaven Island

The Calderwood Formation on Vinalhaven Island was mapped in order to find clues to its origin, stratigraphy, and correlation. As originally mapped and defined by Smith, Bastin, and Brown (1907) the formation included the Calderwood, Polly Cove, and Seal Cove formations of this report. Dow (1965) in general followed the mapping of Smith, Bastin, and Brown. Brookins and others (1973) in a very small scale sketch map limited the Calderwood Formation to the Calderwood and Polly Cove formations as defined herein. The Bedrock Geologic Map of Maine (Osberg and others 1985) shows the Calderwood Formation as extending westward to the east shore of Seal Cove. The present map divides the area originally mapped as Calderwood into four formations, from east to west the Calderwood, Polly Cove, Thorofare andesite, and Seal Cove formations.

Calderwood Formation. This formation is restricted to the highly foliated and metamorphosed rocks that extend from the contact with the Vinalhaven granite on the east shore of Calderwood Neck to the contact with the Polly Cove Formation just east of Polly Cove. The pervasive penetrative deformation distinguishes it from the other formation mapped. The foliation is marked by thin banding, elongate and flattened lenses of various mineralogies, fluxion structures that wrap around clots and lenses, and zones of very strong laminar cleavage. In thinsection, the foliation appears to be cataclastic, and many of the rocks appear to be blastomylonites. Throughout the formation the original cataclastic texture has been overprinted by post-deformation thermal metamorphism that as produced generally unoriented granular intergrowths of several of the following minerals: unstrained quartz, anhedral rarely twinned sodic plagioclase, fibrous to lath-like hornblende (green to blue-green), granular epidote, and a late finegrained olive brown biotite representing an episode of potassium metasomatism. The late biotite commonly follows shears that cut the thermal mineral suite and may contain partially oxidized magnetite and pyrite.

The Calderwood Formation is probably a 2.5 km wide cataclastic shear zone that was metamorposed perhaps by intrusion of the Vinalhaven granite and then sheared again to a lesser intensity during or followed by potassium metasomatism.

The cataclasis and recrystallization have largely erased original textures and mineralogies so that identification of the protoliths is uncertain. Sedimentary structures such as cross-bedding or graded beds, if once present, have been obliterated. The configuration of pillows in basalt on Ash Tree Point is the only suggestion that the formation youngs toward Polly Cove. The protoclastic foliation strikes north to northnortheast and dips steeply to the northnorthwest. Only a few tight overturned folds were found and repetition of rocks due to larger folds were not mapped.

The formation has been tentatively divided into three members on the basis of field and thinsection appearence.

It is assumed that the formation youngs to the west and there is no repetition due to folding.

Member A. This member consists of interlayered hornblende-rich rocks and well-foliated sugary quartz-rich white, green, and lavender layered rocks. The well-layered and banded appearance apparently represents mylonitic banding judging from the blastomylonitic textures seen in thinsection. The lavender bands are rich in the late biotite. The only obvious protolith is a section of pillow lavas on Ash Tree Point. The member may once have been a sequence of basalts and cherts or siltstones.

Member B. Member B is a heterogeneous collection of various calaclastic well foliated rocks. It includes blastomylonitic schists composed of clots and lenses of hornblende, lenses and clots of granular guartz, irregular clots of granular quartz and anhedral feldspar, perhaps once lapilli, layers of fine-grained quartz commonly with small quartz augens, and pyritic quartz-feldspar schists, possibly once feldspathic siltstones. North of Salt Works Cove, there is a section of massive rocks with a fine-grained igneous texture primarily of feldspar with minor quartz, perhaps a latite flow or sill or dike. These gray massive units are bounded and separated by blastomylonitc layers in which traces of the original igneous texture are preserved in the "tails" of augen. Member B is interpreted tentatively to have been originally an assemblage of felsic volcanic rocks and interbedded siltstones and/or cherts.

The contact with Member C is placed along the north shore of Calderwood Neck at highly sheared pyritic zone that is assumed to indicate a fault just offshore of and parallel to the shoreline. The fault(?) contact is continued inland on the basis of a few outcrops of pyritic schist.

Member C. This uppermost member is characterized by its strong foliation and abundance of post-deformation hornblende and epidote. Irregular clots, lenses, ptygmatic dikes, and layers of hornblende, commonly with white feldspathic margins, are scattered through, and often cut across the foliation. In thinsection, the matrix is a blastomylonitic mass of granular unstrained quartz, enhedral feldspar, fibrous hornblende, and granular epidote. Locally discontinuous late shears cut the metamorphic minerals and contain magnetite, partially oxidized, and fine-grained biotite. One outcrop as shown by its thinsection is a strongly sheared gabbro with remnants of gabbroic texture, plagioclase, and pyroxene partially replaced by hornblende and epidote. One outcrop has pillow-like structures. In thinsection the shelvages around the "pillows" are quartz-feldspar-epidote-hornblende blastomylonites. Perhaps the shearing was channeled along the margins of the original pillows. Member C was mapped in the field as a section of amphibolites. However, there is too much quartz to suggest basalts, and much the the hornblende seems to be random replacement rather than replacement of pyroxene or latent mafic minerals in a glassy basalt. Member C is named a quartz ampibolite buts its protoliths are unknown.

The contact with the Polly Cove Formation along the shore occurs at a diabase dike and a small pebble beach. The overlying bedded siliceous argillites of the lower part of the Polly Cove formation near the hidden contact are only slightly sheared but have the same hornblende-epidote replacement assemblage as the Calderwood Formation. On the hill south and slighly east of Polly Cove, a coarsely bedded breccia of angular fragments of white quartz in a hornblende rich matrix overlies rocks typical of Member C along an unexposed contact and is overlain by the Polly Cove argillites. In thinsection, the breccia consists of angular quartz grains, some plutonic and some granular, and a few possible fragments of mylonite. The matrix is primarily fibrous hornblende and granular epidote. There are a few late discountinuous shears. This breccia is tentatively interpreted to be a small lense of a quartz mudstone marking an unconformity between the Calderwood and Polly Cove formations.

The age and correlation of the Calderwood Formation is speculative. Smith, Bastin, and Brown (1907) considered it to be equivalent to the Islesboro and Penobscot formations believed to be of Cambrian age because of its foliation and metamorphism. Dow(1965) noting the presence of lavender beds in what he considered to be the upper part of the Cranberry Island Series (Deadman/Point Formation) and in the lower part of the Calderwood, concluded that the Calderwood was the stratigaphic continuation of the former. On his map of Vinalhaven Island, Dow listed the Calderwood as Pre-middle Silurian. According to this correlation, Dow's Cranberry Island Series would also be Pre-middle Silurian, an age in conflict with Brookins (1973) Rb/Sr age of Early Devonian.

However, there are resemblances between the Deadman Point and Calderwood formations. Both are cataclastically penetratively deformed; both have the same metamorphic mineral assemblage, including the late biotite metasomatism; both have basalt flows; and both are intruded by granitic rocks. Hence on lithologic grounds a correlation is possible. To carry on further into the realm of speculation, if the Calderwood unconformably underlies the Polly Cove Formation and the Polly Cove is conformable with the Thorofare Andesite (see following page) then the Calderwood may be of Pre-middle Silurian age. If it correlates with the Deadman Point Formation, then the latter may be Pre-middle Silurian and much older than the Great Cranberry Island Formation. In that case the fault between the two formations must be a major one. The implication is that the original cataclastic may be, but does not have to be, pre-Acadian. However, this is in conflict with the evidence that the cataclastic deformation on Great Cranberry Island near the fault occurs also in the upper part of Member H of the Lower Devonian Great Cranberry Island Formation. Clearly more geologic information is necessary to narrow the options regarding the age and correlation of the Calderwood Formation.

A correlation that cuts this Gordian knot is to conclude that the Calderwood is a sheared and contact metamorposed equivalent of the bimodal volcanic rocks in the upper part of Cambro-Ordovician (?) Ellsworth Formation (Stewart, personal communication).

Polly Cove Formation. This formation crops out along the shore of Polly Cove. Previous reports (Smith, Bastin, and Brown 1907; Dow 1965) have included it as part of the Calderwood Formation. It consists of a lower section of well-bedded argillite separated from the rest of the formation by a small gravel beach. Next is a folded and faulted section of lavender, green, and white beds largely of epidote, hornblende, and quartz, perhaps metamorphosed calcareous siltstones, followed by bedded vitric crystal tuffs and tuffaceous siltstones. Exposures on the rounded point forming the northwest side of Polly Cove consists of laminated argillite, thick massive felsic lapilli tuffs and tuff-breccias, pebble conglomerates with volcanic clasts, and pebbly mudstones. The rocks are faulted and intruded by andesitic dikes. The epidote-hornblende metamorphic assemblage is present but the rocks are not penetratively and cataclastically deformed.

Thorofare Andesite. The Thorofare Andesite was named by Smith, Bastin, and Brown (1907) for exposures long the north shore of the Fox Islands Thorofare. It is probably of Late Silurian to Early Devonian age (Brookins and others 1973). The rocks mapped as Thorofare Andesite west of Polly Cove were included in the Calderwood Formation by Smith, Bastin, and Brown (1907) and Dow (1965). The formation is a mixture of andesitic tuff-breccias, block and boulder breccia, andesite flows, and maroon bedded conglomerates, sandstones, and shales. West and southwest of Polly Cove, the formation is largely and andesitic tuff-breccia with dikes of porphyritic andesite. The contact with the Polly Cove Formation can be interpreted as intrusive,conformable, or unconformable. Further field work is needed.

Seal Cove Formation. This formation was mapped as Calderwood by Smith, Bastin, and Brown (1907) and Dow (1965) probably because is has undergone the epidote-hornblende metamorphism typical of Calderwood although it lacks the cataclastic foliation. Dips are consistently to the northwest, the younging direction indicated by cross-bedding. The contact with the Thorofare Andesite is probably a sedimentary one although in some places that contact can be interpreted as the Thorofare intrusive into the Seal Cove. The lower part of the Seal Cove Formation is a thick massive tuff-breccia of felsic volcanic fragments, broken feldspar crystals (albitized) and a few broken quartz grains. Minor basalt and andesite fragments are also present. The overlying rocks along the east shore of Seal Cove are well-bedded tuffs, feldspathic siltstones, and siliceous argillites. There is also a basalt flow. As the granite contact is approached,the rocks become lavender, white, and green reflecting increasing epidote-hornblende and late biotite metamorphism. On the point ooposite Brown Island very close to the granite contact, metamorphic minerals include a pale yellow garnet (grossularite?), zoisite, and very fine-grained diopside, suggesting an original calcareous sedimentary rock.

The rocks of the Seal Cove formation along the west shore of Seal Cove are a very well and thinly bedded section of siltstones and mudstones, many of which display delicate cross-bedding, graded bedding, and intricate load casting and soft sediment deformation structures. The section has some widely spaced open folds that may be penecontemporaneous due to incipient slumping. The epidote-hornblende metamorphism increases as the contact with the granite at the head of Seal cove is approached. Mapping of the Seal Cove Formation stopped at a thick gabbro intrusion so that its relationship to the Vinalhaven rhyolite to the west remains to be determined.

References

Brookins, G. D., Berdan, J. M., and Stewart, D. B., 1973, Isotopic and paleontological evidence for correlating three volcanic sequences in the Maine coastal belt; Geological Soc. of America Bulletin, v.84, p. 1619-1628.

Dow, G. M., 1965, Petrology and structure of North Haven Island and vicinity, Maine; PhD dissertation, University of Illinois, Urbana, 146 p.

Gilman, Richard A. and Chapman, Carleton A, (1988) Bedrock geology of Mount Desert Island; Maine Geological Survey B ulletin 38. Augusta

Osberg, P. H., Hussey, A. M, II, and Boone, G.M., 1985, Bedrock Geologic Map of Maine, Maine Geological Survey, Augusta.

Smith, G., O., Bastin, E. S., and Brown, C. W., 1907, Penobscot Bay Folio, Maine, S. S. Geological Survey. Washington D. C.

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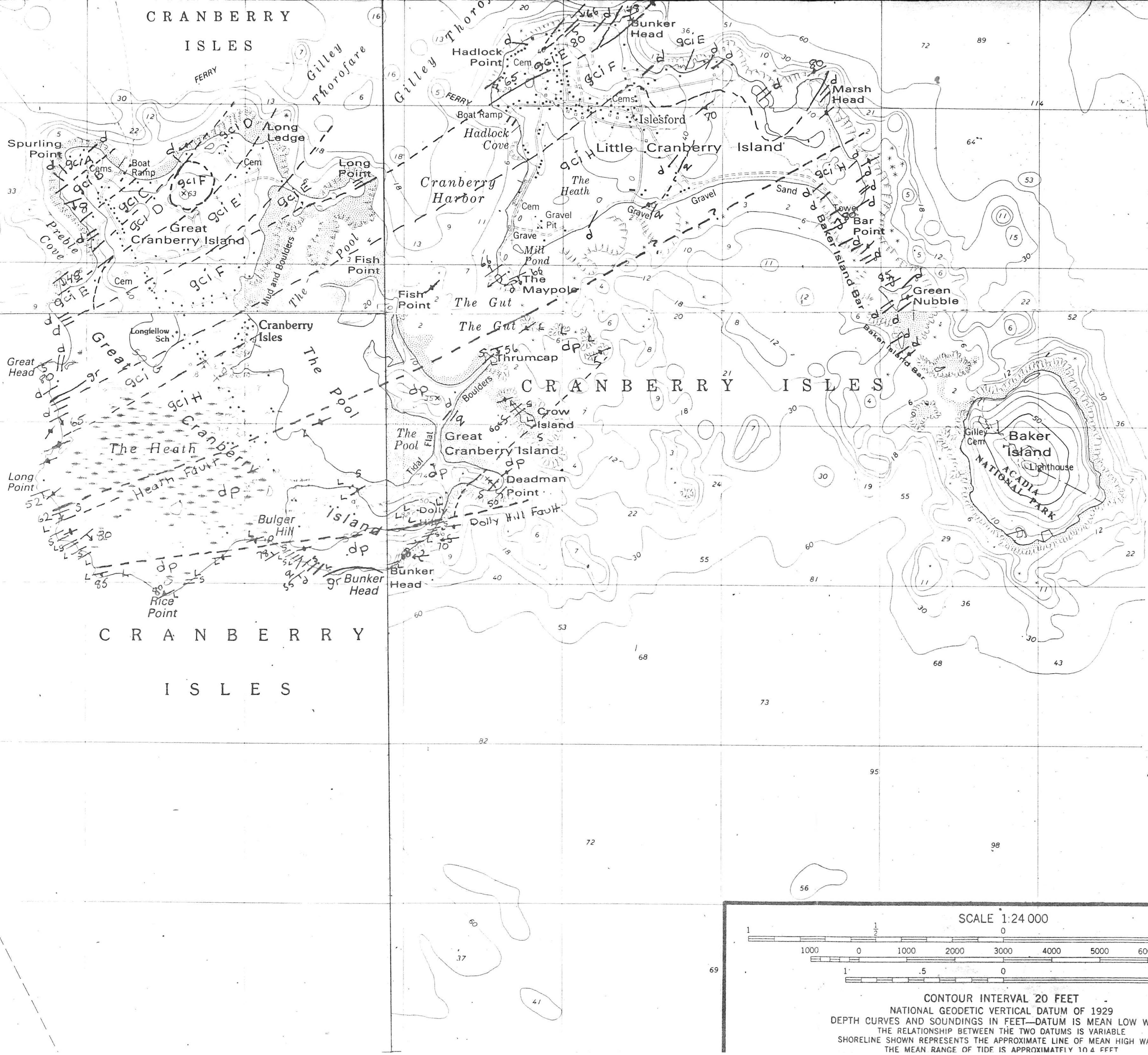


GEOLOGIC MAP, CRANBERRY ISLANDS, MAINE

gr. Granite (Devonian)
q. Quartz porphyry dikes (Silurian-Devonian)
d. Diabase dikes (Silurian-Devonian)

Intrusive contact

Silurian-Devonian

gci. Great Cranberry Island Formation members
- H. Massive debris flow or landslide breccia; clasts of felsic volcanics, mafic flows, tuffaceous sandstones and siltstones; feldspathic mudstone matrix; minor bedded sediments.
- G. Tuffaceous pebble conglomerate, sandstone and siltstone, locally disrupted.
- F. Devitrified vitric feldspar porphyry.
- E. Flowbanded spherulitic devitrified vitrophyre; autobreccia; tuff-breccia (E'); bedded tuffs;
- D. Bedded felsic tuff-breccia, lapilli tuffs, pebble conglomerate, tuffaceous sandstone and siltstone.
- C. Disrupted felsic tuffs, siltstone, and mudstone.
- B. Bedded felsic tuffs, siltstone, mudstone.
- A. Roundstone polymict conglomerate and tuff-breccia.

Fault contact

Age ?

dp. Deadman Point Formation.
Cataclastically deformed, tightly folded, contact metamorphosed siltstones and mudstones interlayered with mafic lavas. L lava flows, S sediments where outcrops permit differentiation.

Symbols

- Contact
- Contact inferred
- Fault
- Fault inferred
- Attitude of bedding
- Top criteria
- Attitude of flowbanding
- Attitude of minor folds
- Attitude of cataclastic foliation

Mapping by Olcott Gates 1988

GEOLOGIC MAP, PART OF SWANS ISLAND, MAINE

gr. Granite (Devonian ?) d. diabase dikes

Intrusive contact

si. Swans Island Formation

member

Silurian ?

C. Flowbanded dacite-rhyolite; auto-breccia.

B. Basalt flows; minor siltstone (S).

A. Sheared and folded contact metamorphosed siltstones, felsic tuffs and flowbanded rocks; volcanic breccia; minor basalt.

Symbols

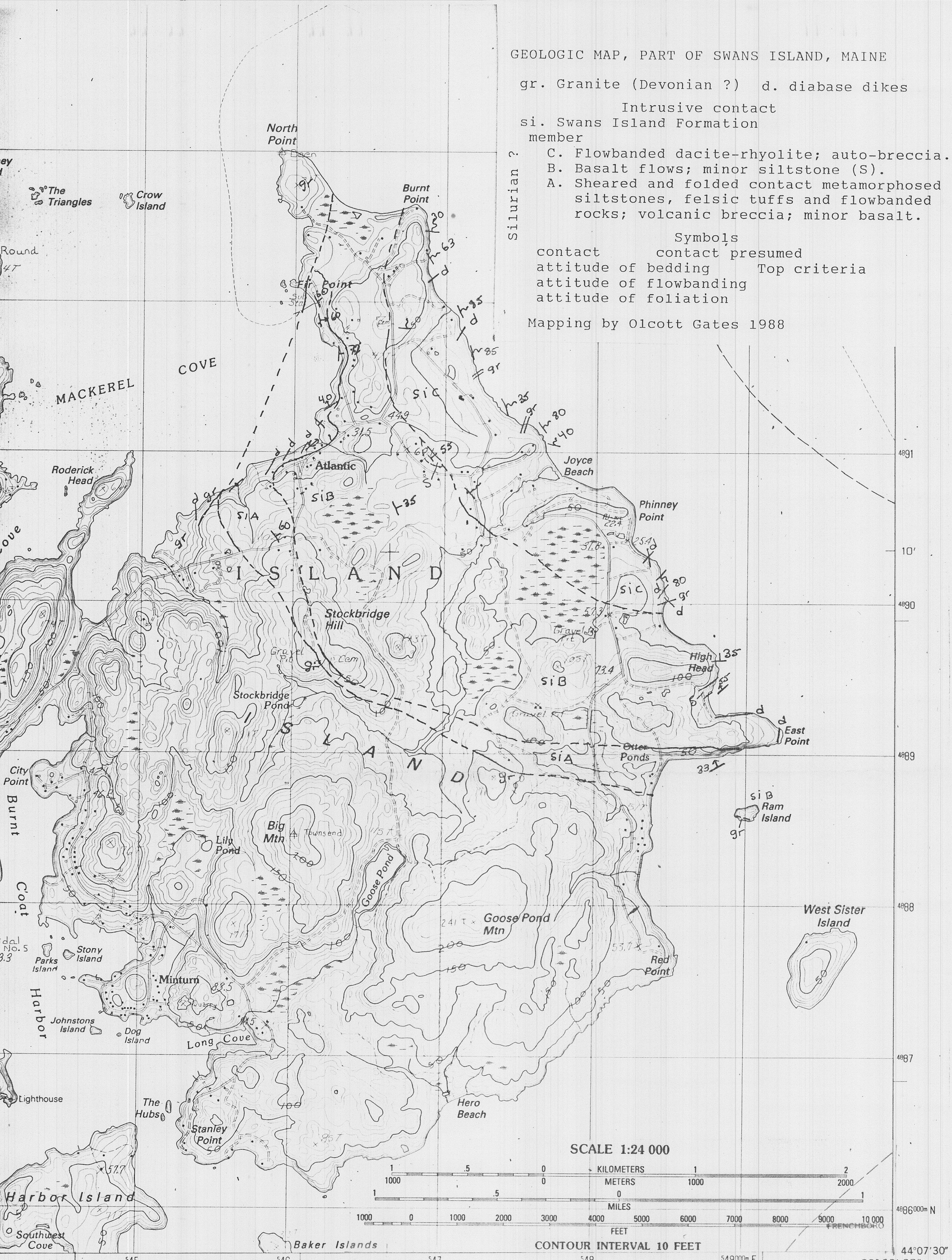
contact contact presumed

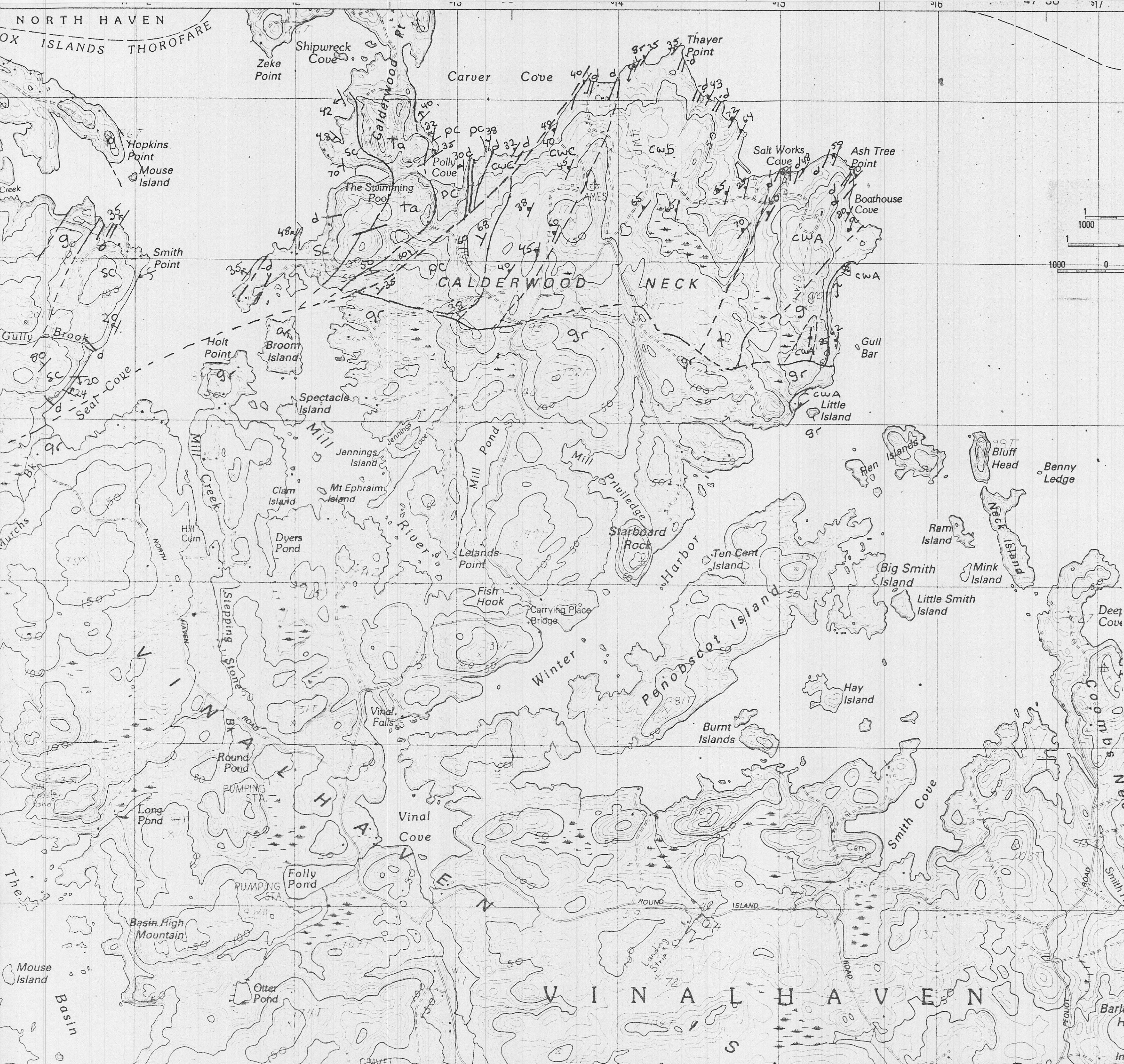
attitude of bedding Top criteria

attitude of flowbanding

attitude of foliation

Mapping by Olcott Gates 1988





GEOLOGIC MAP, PART OF VINALHAVEN ISLAND, MAINE

gr. granite (Devonian) g. Gabbro (Devonian)
d. Diabase dikes and sills (Silurian-Devonian)

Intrusive contact

Silurian-L.Devonian

sc Seal Cove Formation.
Massive felsic tuff-breccia overlain by bedded felsic tuffs, siltstones, mudstones; a basalt flow.

ta Thorofare andesite.
Coarse andesitic breccia and lava flows.

pc Polly Cove Formation.
Bedded felsic tuffs, tuffaceous sandstones and siltstones; pebble conglomerate;argillite

Unconformity ?

Age ?

cw Calderwood Formation.
Member
C Foliated quartz amphibolite, locally blastomylonitic.
B Foliated blastomylonitic quartz schists, latite? volcanic rocks.
A Foliated blastomylonitic quartz schists, pillow basalt, basalt.

Symbols

contact — contact inferred
fault — fault inferred
attitude of bedding — top criteria
attitude of blastomylonitic foliation
plunge of minor folds

Mapped by Olcott Gates 1988